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Specialization without Regret

Transfer Rights, Agricultural Productivity, and Investment in an Industrializing Economy

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In China, where collectives own farmland but farmers may hold 'use rights" to the land, a case can be made for a property rights system with incomplete security of tenure but with strong transfer rights, which permit "specialization without regret" — so farmers can recoup the value of an investment even if they exit farming

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Summary findings

A number of studies have examined the effects of secure tenure on agricultural investment and productivity. Carter and Yao also study the importance of rights to household residual income and land use being transferable.

Contemporary China — where industrialization has spread rapidly, if unevenly — is a good place to study the economic effects of transfer rights as well as conventional security of tenure. Village collectives formally own land in China, so there can be no individual land sales, but farmers are sometimes entitled to sell their rights to use the land allocated to them under the household responsibility system.

Whether a household has secure tenure depends on whether its landholding will be reduced if the household population declines, whether the landholding will be increased if the household population increases, and how frequent average land adjustments are under the household responsibility system.

Analyzing panel data for a sample of farm households, Carter and Yao study the "investment regret mitigation effect," which results when greater transfer rights make households more willing to invest because they are less likely to regret such investments when they can recoup the investment value even if they exit farming.

Carter and Yao find that transfer rights may be especially important in an industrializing economy. A property rights system with incomplete security of tenure but with strong transfer rights that permit "specialization without regret" — so farmers can recoup the value of an investment even if they exit farming — may have much to recommend it.

This paper — a product of Rural Development, Development Research Group — is part of a larger effort in the group to study the determinants and impact of property rights systems and land tenure regimes in the process of development. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Maria Fernandez, room MC3-542, telephone 202-473-3766, fax 202-522-1151, Internet address mfernandez2@worldbank.org. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/html/dec/Publications/Workpapers/home.html. The authors may be contacted at carter@aae.wisc.edu or yyao@ccer.pku.edu.cn. October 1999. (50 pages)

SPECIALIZATION WITHOUT REGRET: TRANSFER RIGHTS, AGRICULTURAL PRODUCTIVITY AND INVESTMENT IN AN INDUSTRIALIZING ECONOMY*

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Specialization without Regret: Transfer Rights, Agricultural Productivity and Investment in an Industrializing Economy

Among those mutable factors that constrain economic performance in low income and transitional economies, property rights over land rank high by most calculations.[1] With a few important exceptions, the literature that has tried to quantify the economic effects of property rights has concentrated on the security with which individuals hold rights over land. The goal of this paper is to broaden the focus of these earlier efforts to include transfer rights, meaning an individual's liberty to rent or sell the use, income and other rights that he or she holds. Theoretically this paper shows that transfer rights permit specialization in off-farm activities

economy industrializes and its population begins to specialize in non-agricultural activities. Transfer rights should also facilitate (shadow) factor price equalization across households and resolve problems of allocative inefficiency that are likely to become more severe under the pressure of industrialization. This paper's econometric analysis of household level panel data from China largely corroborates these theoretical propositions concerning transfer rights. With its finding that transfer rights seem to matter more than tenure security, the empirical analysis also suggests some novel directions for future property rights reform in China.

The liberalization of transfer rights has emerged as a contested and yet poorly understood policy issue in a number of countries, both in those where land is or until recently has been held under customary tenure arrangements, and in those where earlier redistributive reforms reshaped land ownership structure. This paper considers transfer rights in the context

[1] See for example the discussion in Alston, Libecap and Schneider (1996) and the many references contained therein.

of China and its particular history of reforms that generated a highly egalitarian distribution of land.[2] China's household responsibility system reform of the late 1970s and early 1980s replaced collective production teams with household-based production units, and assigned use and residual income rights to individual households. Transfer rights and tenure security were not fixed nationally at the time of these reforms, and they have been subject to local determination and subsequent evolution (Liu *et al.* 1998).

A number of analysts have credited the hybrid property rights system created by the household responsibility system reforms for the rapid and sustained agricultural growth that took place in China in the early 1980s. While the exact weight of the reform in this growth spell can be disputed,[3] there is little doubt that the reforms unambiguously sharpened individual work incentives. Moreover, for an economy that was labor intensive and where most rural people worked full-time in agriculture, the reforms should also have attained approximate allocative efficiency without any factor market transactions given that land was allocated to families in rough proportion to their labor endowments (Burgess 1998). The limited transfer rights and weak tenure security that emerged in many areas may have been relatively unimportant in the initial post-reform period.

However, the subsequent and rapid growth in industrial employment and wages has undercut the conditions that may have rendered transfer rights unimportant.[4] With the

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[2] Liberalization of transfer rights could be argued to work differently in less egalitarian economies (e.g., Mexcio or Nicaragua) because large wealth differentials create potentially radically different patterns of capital access that spill over and influence the function of the land market (*e.g.*, see Carter and Salgado, forthcoming).

[3] Lin (1992) and MacMillian, Whalley, and Zhu (1989) argue that the property rights reform was central, while Putterman (1992) warns that their analysis overstates the importance of property rights reform relative to price reform.

[4] Carter and Yao (1998) for example show that land-labor endowment distribution has become more disperse over time.

slowdown in agricultural growth after mid-1980s, the wisdom of the hybrid, village-based land tenure system has come under both academic and policy scrutiny. Some argue that restricted transfer rights and frequent insecurity-inducing land redistribution and small landholdings rooted in the village-based land tenure system have become the major hindrance to the improvement of agricultural productivity. Others argue that whatever its costs, the current land tenure system provides important benefits by functioning as a mechanism of rural social insurance (Dong, 1996 and Kung 1994).

While the work presented here does not address the social insurance benefits of the current system, it does try to identify the more narrowly construed investment and productivity benefits that might attend a further liberalization of property rights. To this end, Section 1 below develops a two period model that identifies three kinds of effects that further property rights reform in China may have:

1. *A Security-Induced Investment Demand Effect* that results when households perceive a reduction in the likelihood that land in which they might sink, attached, long-lived investment will be reallocated to other households[5];

2. *An Investment Regret Mitigation Effect*, that results when greater transfer rights make households more willing to make investments because they are less likely to regret sinking investment in the land because they become able to recoup the value of the investment even if they should exit farming.

3. *A Factor Price Equalization Effect* that results when increased transfer rights facilitate the equalization of returns to land, labor and short-lived capital between household farming units.

The first of these three effects has been studied extensively in the literature (see the summary

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[5] We omit the collateral effect because land is not allowed to be used as loan collateral in current China. Besides, using land as a collateral is a doubtful punishment for loan default in an economy where land per capita ranges from only one thirtieth to one tenth of a hectare, as our survey revealed (Table 1).

by Feder and Akihiko, 1996).[6] Distinguishing it from the latter two effects, which result from liberalized transfer rights, faces a number of challenges, including the fact that transfer rights and tenure security often move together. Fortunately, the theory developed in Section 1 below suggests a number of quite specific tests that permit us to distinguish security from regret and factor price equalization effects. Many of these tests are variations on what have become known as separabilty tests that ask whether shadow prices and factor choices in production independent of household endowments and consumption choices. Interestingly, the modeling done here suggest that much conventional separability testing has been mis-specified in the sense that non-separability, if it holds at all, applies differently across different market participation regimes and that a single regression model that pools observations across regimes is inappropriate.

Section 2 develops an econometric implementation of the theoretical model. While offering a powerful, if statistically conservative, control for latent variables, the panel data methods put forward force reliance upon simulated maximum likelihood (SML) methods given multiple land market participation regimes and the presence of censoring in the investment data. Using data collected in 1988 and 1993 on a sample of 400 rice-producing households spread across 40 villages in 2 Chinese provinces, Section 3 then presents the SML results. While the models and methods demand a lot of the data, both investment regret and factor price equalizations effects prove significant. Interestingly, the tenure security effects

[6] For China, recent studies by Rozelle, Li and Brandt (1998), Carter and Yao (1998), and Jacoby Li, and Rozelle (1998) find some evidence of tenure security effects, standing in contrast to the earlier study by Feder, Lau, Lin, and Luo (1992) who found that the link between farmers' perception of tenure security and farm investment was very weak if positive at all. The investment regret effect is similar to what Besley identifies as the terms of trade effect, while the factor price equalization effect has parallels to Gavian and Fafchamps (1996) tests of allocative inefficiency.

appear insignificant. As discussed in the concluding Section 4, these results provide insights into promising directions for further property rights reform.

Section 1 A Model of the Impact of Tenure Security and Transfer Rights on Allocative Efficiency and Investment Incentives

This section develops a two period model that identifies the avenues through which transfer rights and tenure security affect agricultural productivity and investment. Constrained by the degree of tenure security and land transfer rights that they hold, households in the first period make investment decisions and allocate variable factors of production between on- and off-farm uses, taking into account the expected impact of these decisions on their future wellbeing. Prior to the second period, two village-level shocks are realized, a land redistribution shock and an off-farm employment growth shock. Households then allocate variable factors of production for second period production. In order to highlight the factor price equalization effect of land transfer rights, this section first analyzes this model for the special case in which there is no prospect that off-farm TVE employment will expand in the second period. We then consider the more general case of employment growth shocks and show the additional impacts generated by the resulting investment regret effect.

1.1 The Model

Households enjoy endowments of labor time, $\overline{L}$, and contract land, T^c. The exact bundle of rights held over contract land is variable and is detailed below. Each period, households divide their endowment of family labor between on-farm agricultural uses (L^f), home or sideline enterprises (L^s), and wage employment in township and village enterprises

(L^w). Income in these activities is generated as follows:

$$A_i F(K, T^f, L^f),$$

$$g(L^s); \text{ and,}$$

$$wL^w,$$

where A_i is a household-specific technical efficiency (or agricultural comparative advantage) term, K is capital, T^f is farmed or operated land F is a conventional constant returns to scale production function with positive cross partials (*e.g.*, $F_{LK}>0$).[7] We assume that returns to labor allocated to sideline diminish ($g' > 0$, $g'' \leq 0$), and that the TVE wages exceed the marginal agricultural labor product (Yao 1998) such that the time allocated by a household to these activities is bound by the constraint $L^w \leq \bar{L}^w$.

Capital in the agricultural production function is long-lived, and attached to the land. Examples of such capital include terraces, fencing, and fertile soil. In first period, there is no inherited capital stock, and all capital is purchased by a price of r_K, and capital goods are spread out evenly across a farm's cultivated area (both own and rented land). To sidestep issues concerning investment disincentives on rented land, we assume that landlords pay a per-*mu* rebate of $k_I v_k$, where k_I is the installed capital stock per-*mu,* and v_k is the rebate rate that

[7] Because in our particular empirical application, households' endowments of productive resources are small enough that labor hiring is trivial (except for peak season agricultural tasks), we ignore hired labor, effectively assuming that households are optimally in the regime where no labor hiring is desirable. Generalizing the model to consider hired labor could take one of two directions. The first would be to assume that labor effort—measured in efficiency units—can simply be hired at a fixed agricultural wage rate. A second, and more realistic approach, would be to assume that households face what Bowles (1985) calls a "labor extraction" problem, meaning that without supervision or other incentives, hired laborers supply very little efficiency labor per-unit time. Under the latter specification, the model changes little if supervisory costs increase with farm size as the equilibrium shadow wage will increase with farm size, as in the present model.

that individuals expect to equal to their expected marginal second period use value of capital.[8]

Households hold full current use and residual income rights to their contract land endowment. There are, however, two other important dimensions of the property rights to contract land. First, as discussed above, in some areas of rural China, households may not rent-out their land, while in other areas land renting is allowed subject to various conditions that range from shifting the incidence of the land tax and other collective duties, to obtaining the acquiescence and approval of local authorities. In still other areas, land may be freely rented with no restrictions or regulation (see Liu *et al.*, 1998). The severity of restrictions on private transfers of land rights, M, is defined such that higher values indicate less encumbered (more freely transferable) land rights. We assume that the restrictions on land transactions create a per-*mu* cost, $c^O(M)$ (with $c^{O\prime}<0$) for those that rent-out land; and, $c^I(M)$ (with $c^{I\prime}<0$) for those that rent-in.[9] The net returns from renting out R^O units of land are thus $R^O(r^t - c^O(M))$, while the total cost of renting in R^I units of land is $R^I(r^t + c^I(M))$. We assume that second period transfer rights, M_2, are given by:

$$M_2 = M_1 + \mu,$$

where μ is a random variable with a mean of zero so that institutional expectations are regressive in the sense that $E(M_2) = M_1$.

In addition to limited land transfer rights, households may confront a degree of tenure insecurity. In contemporary China, tenure insecurity results from the probability that village authorities will reallocate land among villagers based on changes in household labor force composition, consumption needs, or other considerations. The willingness of village

[8] A more realistic portrayal might specify the rebate rate to be the outcome of a bargaining process between landlord and tenant and hence to be between the use values of capital for these two agents.

authorities to reallocate land and the resulting degree of tenure insecurity varies across rural China (see Liu *et al.*, 1998 and Kung, 1994). We assume that when a redistribution shock occurs, all land in the village is redistributed and that a household has zero probability of retaining any of its prior allocation of contract and rental land. Denote the probability that a reallocation shock occurs as $q(S)$, where S is the level of tenure security (or immunity from redistribution) defined such that $q'(S) < 0$.

Given this structure of opportunities and rights, we assume that conditional on optimal second period behavior households make first period choices in order to:

$$
\begin{aligned}
&\underset{\substack{L_1^f, L_1^s, \\ R_1^I, R_1^O, K_1}}{Max} && A_i F(K_1, T_1^f, L_1^f) + w\bar{L}_1^w + g(L_1^s) - r_1^t K_1 - \\
& && \quad R^I(r_1^t + c^I(M_1)) + R^O(r_1^t - c^O(M_1)) + \beta E[\pi_2^*(..)] \\
& && s.t. \\
(1) \quad & && L_1^f + L_1^s \le \bar{L} - \bar{L}_1^w \\
& && R_1^O \le T^c \\
& && T_1 = T^c + R_1^I - R_1^O \\
& && L_1^f, L_1^s, R_1^I, R_1^O \ge 0
\end{aligned}
$$

where π_2^* is the optimum value function corresponding to the second period problem (detailed in Appendix 1) and β is the discount factor. Ignoring the trivially slack inequality restrictions on labor and land rental, this model yields the following first order conditions:

$$
\begin{aligned}
& Af_\ell - \tilde{\omega} = 0 \\
& Af_k - r_1^k + \beta \tilde{r}_2^k = 0 \\
(2) \quad & -Af + (r_1^t - c^O(M_1)) \le 0; \;\; R_1^O \frac{\partial \pi_1}{\partial R_1^O} = 0 \\
& Af - (r_1^t + c^I(M_1)) \le 0; \;\; R_1^I \frac{\partial \pi_1}{\partial R_1^I} = 0
\end{aligned}
$$

[9] For those that rent land out, these costs can be thought of as political retribution costs. For those that rent-in,

where the assumption of constant returns to scale has been used to rewrite the first order conditions in terms of agricultural labor and capital intensity per-unit land (ℓ and k) and $f(\ell,k)$, average output per unit of land. The term $\tilde{\omega} \equiv g'(\bar{L} - (\bar{L}_1^w + L_1^f))$ is the endogenous shadow price of labor, and $\tilde{r}_2^k \equiv \beta(\partial E\pi_2^*/\partial K_1) = \beta(1-q)\partial\pi_2^*/\partial K_1$ is the endogenous expected second period shadow value of first period investment. Appendix 1 shows that under mild assumptions, this latter term reduces to:

$$\tilde{r}_2^k = \beta(1-q)Af_K(\ell_2^*, k_2^*) \tag{3}$$

where ℓ_2^* and k_2^* are optimal second period factor intensities in agricultural production.

The first period maximization problem admits three distinct land rental regimes: one where land is rented in ($R_1^I > 0$; $R_1^O = 0$); one where land is rented out ($R_1^I = 0$; $R_1^O > 0$); and, a double corner solution or autarchy regime where no rental transactions take place. Households in the autarchy regime will, by definition set $T_1^f = T^c$ and in autarchic equilibrium the dual corner solution condition must hold:

$$(r_1^t - c^o(M_1)) < Af(\ell_1^{A*}, k_1^{A*}) < (r_1^t + c^I(M_1)), \tag{4}$$

where ℓ_1^{A*} and k_1^{A*} denote the optimal autarchy factor intensities. Note that households will be found in the autarchy regime because of the price wedge between net price for renting-in versus renting-out land.

1.2 Security-Induced Investment Demand Effect

Tenure security influences labor and investment intensities through its impact on the shadow price of the first period investment in the second period production. From (3), it is easy to see that the shadow value $\tilde{r}_2^k$ of investment is increasing in tenure security, S, as will

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they can be thought of the search costs that occur when legal uncertainties render markets thin.

be first period investment intensity k_1^*. Under the assumption stated above that $F_{LK} > 0$, optimal labor intensity per-unit land will also increase with tenure security, S. In contrast to the affects associated with land transfer rights to be analyzed in the next sections, this conventional investment demand tenure security effect holds for all households irrespective of land rental regime.

1.3 Factor Equalization Effect of Land Transfer Rights

To derive the factor price equalization effects summarized in Table 1, first consider the behavior of the endogenous shadow factor prices within each land rental regime. As shown in the appendix, for households in the autarchy regime:

(5) $\partial \widetilde{\omega}_1^{A^*} / \partial T^c > 0;\ \partial \widetilde{\omega}_1^{A^*} / \partial \overline{L} < 0$; and $\partial \widetilde{\omega}_1^{A^*} / \partial M_1 = 0$.

Optimal labor intensity, $\ell_1^{A^*}$, moves in the opposite direction of the shadow price of labor (*e.g.*, $\partial \ell_1^{A^*} / \partial T^c < 0;$). Labor intensity by households in the autarchy regime thus varies with household land endowment. Intuitively, this "non- [10] results because following an increase in its contract land endowment, a household would begin to reallocate labor from competing use in sideline activities ($g(\bullet)$) toward agricultural production. However, as it did so, the shadow price of labor would rise, and the optimal labor intensity of agricultural production would fall.[11] In addition, for households in the autarchy regime, a larger endowment means that the future use value of investment will be lower as a higher shadow

[10] Strictly speaking, the term non-separability refers to models in which the consumption choices of a joint production/consumption unit are inseparable from production choices. However, as in the present model, such standard non-separability creates a relationship between factor choice and wealth, and results from the same market incompleteness that drive results in our model under autarchy.

[11] Note that if investment activities require labor, this same effect also increases the direct (labor) costs of investment

value of labor means that the investment will be exploited less intensively. The second period shadow value of first period investment thus also decreases with land endowment: $\partial \tilde{r}_2^k / \partial T^c < 0$, and desired capital intensity would diminish with it. Shadow factor prices are not equalized across households within this regime as both the shadow wage and the second period shadow value of investment change with endowments.

In contrast to behavior within the autarchy regime, the resource allocation by households in the rent-in and rent-out regimes is separable from endowments and is formally identical to what would happen in case of perfect rental markets (with the exception of course that there is a transaction costs wedge between the rental rates faced by households that rent-in land versus those that rent-out). In this case, factor intensities become independent of household endowments of land and labor: $\partial \tilde{\omega}_1^{A^*} / \partial T^c, \partial \ell_1^{A^*} / \partial T^c = 0$. Appendix 1 further shows that freer land transfer rights diminish the wedge between net rental rates, and that, with some qualifications:

$$\partial \ell_1^{I^*} / \partial M_1 < 0; \ \partial \ell_1^{O^*} / \partial M_1 > 0, \tag{7}$$

where $\ell_1^{I^*}$ and $\ell_1^{O^*}$ are the labor intensities of the rent-in and rent-out regimes, respectively. Again, qualitatively identical results can be obtained for capital choice. Intuitively, households exploit the comparative advantage created by their relative endowments by using the land rental market to adjust the size of their operated holdings. Within, but not between, each of these regimes, shadow factor prices ($\tilde{\omega}$ and $\tilde{r}_2^k$) are equalized. Note that shadow prices and optimal factor intensities within each regime are functions of transaction costs and transfer restrictions, and that as these diminish, the factor intensity in the rent-in regimes shrink, while those in the rent-out regime increase, moving the shadow prices and factor intensities in the

two regimes closer together.

We are now in a position to see the threshold and full factor price equalization effects of land transfer rights. In the autarchy regime, as contract land endowment T^c increases, land productivity decreases. For a given level land transfer rights, M_1, and transaction costs, $c^O(M_1)$, there will occur a critical or threshold endowment value, $\tilde{T}^o$, beyond which households will optimally rent-out positive amounts of land. Symmetrically, given M_1 and $c^I(M_1)$, as contract land endowment shrinks, factor intensities rise and there will occur a critical land endowment level, $\tilde{T}^I$, below which households will violate the corner solution condition in (4) and rent-in positive amounts of land. As land transfer rights increase and transaction costs decrease, the rental threshold points squeeze together (*i.e.*, $\partial \tilde{T}_1^I / \partial M_1 > 0$; $\partial \tilde{T}_1^{O^*} / \partial M_1 < 0$) and the land endowment range over which households will optimally behave in an autarchic fashion decreases.

Figure 1 graphically portrays and summarizes the the factor price equalization effects of land transfer rights. The solid lines show the relationship between shadow prices and land endowments for a modest level of land transfer rights, M_1^1. As transfer rights become less encumbered (more freely marketable) and move to some $M_1^2 > M_1^1$, the shadow price relationships shift as shown by the dashed lines in Figure 1. Note that the two flat segments for the rent-in and rent-out regimes squeeze together, and that the endowment range over which households behave autarchically diminishes as the threshold values, $\tilde{T}^o$ and $\tilde{T}^I$ squeeze together. Transfer rights do not, however, effect the degree of non-separability for households in the autarchy regime. In the limiting case of complete transfer rights and zero transactions costs, shadow factor prices would be equalized across all households, and the

relationship would reduce to the case of complete separability as shown by the horizontal dotted line shown in Figure 1. Note that short of this case, the sorts of global test of separability found in the literature that do not distinguish between rental regimes (*e.g.*, Benjamin, 1992) would be mis-specified and subject to a degree of bias dependent on the distribution of households across the three regimes.

1.4 Uncertain Off-Farm Employment Growth and the Investment Regret Effect

The analysis so far has assumed that the second period TVE job ration does not change. Suppose instead that second period TVE employment is given by:

$$\bar{L}_2^w = \bar{L}_1^w + \theta, \tag{9}$$

where θ is a random shock that is realized at the outset of the second period and is distributed in the non-negative interval $[0,\bar{\theta}]$ and has a probability density function $\phi(\theta \mid \xi)$. In addition, we assume that this shock is independent of the land redistribution shock discussed earlier. The conditioning parameter, ξ, is used to generate shifts in the density function, with higher values of ξ indicating improved TVE employment prospects in a village. In particular, we rely on the notion of first order stochastic dominance and assume that $\partial\Phi(\theta \mid \xi)/\partial\xi < 0, \forall\theta$, where Φ is simply the cumulative density function corresponding to ϕ.

For a household that optimally rents-in land during the first period, there is some chance that employment growth will be sufficiently strong that the household will cease to rent in land and enter the autarchy regime in the second period.[12] Denote the household's

[12] In theory, a sufficiently large shock could move a household all the way from the rent-in regime to the rent-out regime. However we ignore this case which in any case adds mathematical complexity without changing the qualitative character of the results.

second period autarchy marginal product of land as:

$$F_T^A(\ell_2^A(\theta,T^c),k_2) \tag{10}$$

Because an increase in θ operates like a decrease in household labor endowment, it is easy to see that (10) decreases monotonically in θ. There is a critical value of θ, $\tilde{\theta}^I$, such that a household will stay in rent-in regime when θ is less than $\tilde{\theta}^I$, and will switch to autarky when the opposite is true. To keep matters simple, we will assume that there is no probability that the shock will be so large that a household would move all the way from the rent-in to the rent-out regime.

As can be seen from the second period problem that is detailed in Appendix 1, $\tilde{\theta}^I$ is determined implicitly by the following equation

$$F_T^A(\ell_2^A(\tilde{\theta}^I,T^c),k_2) = r_2 + c^I(M_2) + v_k k_2^I. \tag{11}$$

Using the implicit function theorem, it is straightforward to establish that:

$$\frac{\partial\tilde{\theta}^I}{\partial T^c} < 0, \quad \frac{\partial\tilde{\theta}^I}{\partial M_2} > 0 \tag{12}$$

These two results are intuitive as it takes a smaller employment growth shock to send a household with a large land endowment from renting into autarky, and a less restrictive land transfer rights keep households renting-in land longer even as their notional demand for land becomes quite small.

In the presence of employment growth shocks, the expected second period shadow value of first period investment (equation 3 above) can be rewritten for houselds in the first period rent-in regime as:

$$\tilde{r}_2^{kI_1} = \beta(1-q)[\int_0^{\tilde{\theta}^I} F_K^I(\ell^{I^*},k_2)\phi(\theta\mid\xi)d\theta + \int_{\tilde{\theta}^I}^{\bar{\theta}} F_K^A(\ell_2^A(\theta,T^c),k_2)\phi(\theta\mid\xi)d\theta] \tag{13}$$

where the first integral term is the expected second period value of investment assuming the employment shock is small enough that the household remains in the rent-in regime in period 2, while the second term is the expected value of investment if the shock is large enough to shift the household into the autarchy regime.

As detailed in Appendix 1, analysis of expression (13) reveals that when there is a positive probability of a regime shift ($\tilde{\theta}^I < \bar{\theta}$):

$$\partial \tilde{r}_2^{kl_1} / \partial T^c,\ \partial \tilde{r}_2^{kl_1} / \partial \xi < 0.$$

In other words, the prospect for future specialization in off-farm employment is accompanied by an investment regret effect that depresses current on-farm investment below what it would be in the absence of such future prospects. Moreover, these regret effects are stronger the better are these future prospects (as measured by ξ).

Intuitively, these results can be explained as follows. For a household that in period 1 is in the rent-in regime, a sufficiently large increase in remunerative off-farm wage employment will move the household into second period autarchy. As analyzed earlier, an autarchic household is one that finds it unprofitable to incrementally adjust its cultivated area in the land rental because of transactions costs.[13] Consequently, the household's second period shadow price of labor will increase and the resulting decline in second period labor intensity reduces the second period returns to investment to a level below that which the household would have achieved had it remained a "cheap labor," rent-in household. Any investments that would be made based on the presumption of a abundant family labor in the second period would in fact be regretted in the wake of strong off-farm employment growth

[13] Note also that investment is attached to the land so that it cannot be rented out or sold independently of a land market transaction.

that reduced the returns to such investment. The magnitude of these regret effects increase with the probability of a regime shift (*i.e.*, larger T^c or higherξ) and its attendant increasing labor to land scarcity.

These primary regret effects for households in the first period rent-in regime are mitigated by liberalized transfer rights:

$$\partial^2 \tilde{r}_2^{kI_1} / \partial T^c \partial M_1 > 0; \text{ and,}$$

$$\partial^2 \tilde{r}_2^{kI_1} / \partial a \partial M_1 > 0,$$

(see Appendix 1 for details). Intuitively, transfer rights dampen the regret effects associated with off-farm employment growth because they reduce transactions costs, increase $\tilde{\theta}^I$, and make it less likely that a household will fall into autarchy and experience increasing labor scarcity and depressed investment returns.

Households that are optimally in first period autarchy are also subject to investment regret effects. For these households, here is a critical employment shock value, $\tilde{\theta}^O$, such that a household will stay in autarchy when θ is less than $\tilde{\theta}^O$, and will switch to the rent-out regime when the opposite is true. This critical value can be defined by the appropriate analogue to equation (11) above and Appendix 1 shows that:

$$\frac{\partial \tilde{\theta}^O}{\partial T^c}, \frac{\partial \tilde{\theta}^O}{\partial M_2} < 0. \tag{14}$$

For this first period autarchy case, the expected second period value of first period investment is:

$$\tilde{r}_2^{kA_1} = \beta(1-q)[\int_0^{\tilde{\theta}^O} F_K^A(\ell_2^A(\theta, T^c), k_2)\phi(\theta; a)d\theta + \int_{\tilde{\theta}^O}^{\bar{\theta}} F_K^O(\ell^{o*}, k_2)\phi(\theta; a)d\theta] \tag{15}$$

where the first integral term captures the expected value of investment for those shocks that keep the household in autarchy, while the second term is the expected value for those shocks that render household labor so scarce that the household rents-out land. As before, the magnitude of the regret effect increases with T^c and ξ:

$$\partial \tilde{r}_2^{kA_1} / \partial T^c,\ \partial \tilde{r}_2^{kA_1} / \partial \xi < 0,$$

as increases in both of these factors make it more likely that the household will experience lower returns to installed capital in the second period. Derivation of () is again given in the Appendix 1.

As for households in first period rent-in regime, the magnitude of these regret effects are again mitigated by improved transfer rights:

$$\partial^2 \tilde{r}_2^{kA_1} / \partial T^c \partial M_1, \partial^2 \tilde{r}_2^{kA_1} / \partial a \partial M_1 > 0,$$

as shown in the appendix. An important implication of these investment regret mitigation effects is that they imply that shadow prices and factor choices within the autarchy regime are sensitive to transfer rights. Recall that as detailed in section 2.3, in the absence of employment shocks, transfer rights have no effect on behavior within the autarchy regime.[14]

For households that optimally rent-out land in the first period, there is no investment regret effect. Since these households are already beyond the rent-out threshold, strong growth in off-farm employment will simply lead them to marginally rent-out additional land. By so doing they will receive compensation for investment they made that is identical to their

[14] However, there is no simple, ceterius paribus effect of transfer rights on $\tilde{r}_2^{kA_1}$. As detailed in the appendix, the direct effect of transfer rights on $\tilde{r}_2^{kA_1}$ may be negative for households with relatively small land endowment or when ξ is low, though it is unambiguously positive when these values are large enough.

marginal use value of the capital goods would have been.[15] The expected second period shadow value of investment for these households is thus independent of ξ and these households can specialize without regret.

Figure 2 shows the impact of the investment regret effect on factor intensity. The solid curve displays the predicted relationship between factor intensity and contract land endowment when there is no chance of growth in second period off-farm employment. With a shift toward a positive probability of growth in second period off-farm employment, the relationship shifts toward that shown by the dashed line. As can be seen, the investment regret effect now creates a non-sepearability between factor choice and endowments for households in the rent-in regime. The size of this regret effect and its depressing effect on investment, increases with land endowment for households in this regime. For households in first period autarchy, the regret effect depresses investment, though the effect becomes muted for households with larger land endowments. Households that rent-out land in the first period are unaffected by the investment regret effect. Finally, holding the probability structure constant, the dotted line shows the effect of more marketable property rights on the investment regret effect and desired investment and labor intensity. As property rights becomes more marketable and shift from M_1^1 to M_1^2, the relationship between land endowment and factor intensity rotates and flattens out as shown by the dotted line in Figure

1.5 Summary of Testable Hypotheses

As a prelude to the econometric analysis, Table 1 summarizes the various property rights

[15] Note that had we assumed that the tied investment rental rate, v_k, exceeded the use value of those who rent-out land, we would have found that an increase in off-farm employment prospects would have increased the second period shadow value of investment for households in the rent-out regime.

effects derived in this section. In addition to the standard tenure security effect, transfer rights affect allocative efficiency and investment incentives. If the prospects for future off-farm employment growth are negligible, then the model hypothesizes

1. Non-separable (endowment dependent) factor proportions and transfer rights independence for households autarchy;

2. Separable factor proportions and transfer rights dependence for households in the rent-in and rent-out regimes; and,

3. Transfer rights threshold effects that shrink the band of autarchy;.

When off-farm employment prospects grow probabilistically, there are three additional implications:

4. Investment for autarchic household becomes transfer right dependent;

5. Factor proportions become non-separable for households in the rent-in regime; and,

6. For households in both the autarchy and rent-in regime, transfer rights mitigate the intensity of the investment regret effect.

Tests for implications 4-6 will be key to distinguishing between factor price equalization and investment regret effects.

Section 2 Simulated Maximum Likelihood Methods to Estimate Property Rights Effects using Panel Data

This section develops the econometric model and estimation technique that will be used to test the theoretical hypotheses derived in the prior section. Panel data methods are a key component of the identification strategy and will be used to control for latent individual and village-level factors that would otherwise confound efforts to identify the impact of property rights on investment and productivity. By effectively controlling for systematic differences between villages and individuals, these methods rely on variation in household

behavior over time to identify the impact that property rights have on investment and productivity. While statistically conservative, this method avoids confounding the impact of property rights *per se* with the effect of (time-invariant) village and individual characteristics that may be correlated with either property rights regime or land market participation decisions. After first discussing the land rental decision, this section will discuss the two outcome equations (labor intensity and investment) of interest. Because the investment variable is censored, standard fixed effect methods will not yield consistent results, and simulated maximum likelihood methods are instead developed.

2.1 Land Market Participation

Based on equation (5), the i^{th} farm household's rental decision at time t will be based on its potential autarchy marginal land productivity:

$$f_{it} = Z_{it}\gamma + [v_i^f + \sigma^f \varepsilon_{it}], \tag{16}$$

where the determinants of land productivity, f_{it}, have been partitioned into observable variables (endowments, etc.) Z_{it}, a time invariant latent variable (capturing household farming skill, A_i, local soil quality, etc.) v_{it}^f, and a random noise component, $\sigma^f \varepsilon_{it}$ with $\varepsilon_{it}^f \sim N(0,1)$. Matching the theoretical discussion, the discrete rental regime, R_{it}, is determined by the following ordered probit-like criteria function:

$$R_{it} = \begin{cases} rent-in\ (R^I > 0, R^0 = 0)\ if\ f_{it} > r_{jt} + c^I(M_{jt}) \\ autarchy\ (R^I, R^0 = 0)\ if\ r_{jt} - c^O(M_{jt}) \le f_{it} \le r_{jt} + c^I(M_{jt}) \\ rent-out\ (R^I = 0, R^0 > 0)\ if\ f_{it} < r_{jt} - c^O(M_{jt}) \end{cases} \tag{17}$$

where $c^I(M_{jt}) = c_o^I + c_1^I M_{jt}$ and $c^O(M_{jt}) = c_o^O + c_1^O M_{jt}$ are respectively the rent-in and rent-out transactions costs that are function of the property rights regime in village j at time t. Note

that this specification permits transaction costs to be asymmetric for landlords and tenants.

The latent variable v_{it}^{f} is likely to confound consistent estimation of the parameters in (17) for several reasons. First, household-specific effects that influence land productivity and rental decisions, such as technical efficiency in agricultural production, are potentially related to contract land endowments and other measured variables. In addition, local village factors such as soil productivity, quota obligations and ideological climate are likely related to the economically endogenous local property rights structure (Liu *et al.*, 1998). Similar biases will infect the labor intensity and investment equations developed below. To control for these factors, we follow the approach suggested by Mundlak (1978) and the latent effect as a linear projection of the household's average of Z_{it} in the two periods:

(18) $$v_i^{f} = \bar{Z}_i \delta_f + \theta_f u_i^{f},$$

where $\bar{Z}_i$ is the i^{th} Z_{it} over the t time periods, and we assume that $_{it} \sim$ (,1 . In other words, the $\bar{Z}_i$ are used to instrument for the latent component (cite?). Mundlak (1978) shows that for a standard linear (uncensored) equation, GLS estimation under (18) reduces to a standard fixed effects estimator. While that will not be the case here, as in the linear, fixed effects case, it will be impossible to identify the impact of any Z_{it} that do not vary over time and as with a conventional fixed estimator, the γ will be identified based on within household variation.[16]

Using (18) and (16), the sorting relationship (17) can be rewritten as:

[16] Between household variation is eschewed because under (18) it is inextricably correlated with the latent time invariant factor.

$$(17') \qquad R_{it} = \begin{cases} rent-in\ if\ \varepsilon_{it}^{f} > b_{it} \\ autarchy\ if\ a_{it} \le \varepsilon_{it}^{f} \le b_{it} \\ rent-out\ if\ \varepsilon_{it}^{f} < a_{it} \end{cases}$$

where

$$b_{it} = \frac{1}{\sigma_f}[r_{jt} + c^{I}(M_{jt}) - (Z_{it}\gamma + Z_i\delta_f + \theta_f u_i^{f})]; \text{ and,}$$

$$a_{it} = \frac{1}{\sigma_f}[r_{jt} - c^{O}(M_{jt}) - (Z_{it}\gamma + Z_i\delta_f + \theta_f u_i^{f})].$$

While the rental decision represented in (17′) could be estimated separately as an ordered probit model (with appropriate allowance made for the existence of the household specific effect that render linear panel methods inconsistent), we will instead move toward a full information specification that jointly estimates the rental decision along with the labor intensity and investment decisions.

2.2 Investment and Labor Allocation

The theoretical model in Section 1 identified distinct regimes and hypotheses for investment and factor allocation based on the households participation in the rental market. Econometrically we specify the choice of labor intensity, ℓ_{it}, as:

$$(19) \qquad \ln(\ell_{it}) = \begin{cases} X_{it}^{\ell}\alpha^{I} + v_i^{\ell} + \varepsilon_{it}^{\ell} & if\ R^{I} > 0; \\ X_{it}^{\ell}\alpha^{A} + v_i^{\ell} + \varepsilon_{it}^{\ell} & if\ R^{O}, R^{I} = 0;. \\ X_{it}^{\ell}\alpha^{O} + v_i^{\ell} + \varepsilon_{it}^{\ell} & if\ R^{O} > 0 \end{cases}$$

The explanatory variables have been partitions as before. As with the rental decision, it is likely that both property rights and endowment variables included in the X_{it}^{ℓ} are correlated with the time invariant factor, v_i^{ℓ}. We therefore express the latent, time invariant effect as

v_i $\bar{X}_i \delta$ (θ $_i$ u_i^f u_i^ℓ $N(0\,1)$ and $(\varepsilon_{it}^f, \varepsilon_{it}^\ell)' \sim N(0, \Sigma_{f\ell})$ where

$$\Sigma_{f\ell} = \begin{pmatrix} \sigma_f^2 & \rho_{f\ell}\sigma_f\sigma_\ell \\ \rho_{f\ell}\sigma_f\sigma_\ell & \sigma_\ell^2 \end{pmatrix}. \tag{20}$$

The decision about desired or notional investment per-mu, k_{it}^*, decision can be represented as follows:

$$k^* = \begin{cases} \beta \quad v \quad +\varepsilon \quad if \quad >0 \\ X\ \beta \quad v \quad +\varepsilon \quad R \ ,R \ =0 \\ \beta \quad v \quad +\varepsilon \quad if \quad >0; \end{cases} \tag{21}$$

with analogous assumptions made on the distributions of the latent and error components. Desired investment is subject to Tobit-like censorship such that observable investment, k_{it}, is determined by the following rule:

$$k_{it} = \begin{cases} k \quad if\ k_{it}^* \quad 0 \\ 0, \ otherwise \end{cases}. \tag{22}$$

The error specifications for (19) and (21) are fairly general as they permit the random

factor choice equations. This specification accounts for selectivity-like bias that results from both spontaneous

It is quite possible that the decisions of labor intensity and investment intensity are correlated, making it desirable to estimate the full system defined by (17), and (19)-(22) via a full information approach. However, even under the simulation-based methods to be

integration of trivariate normal distribution which, when added together with the requirements

of the simulation methods themselves, would make for a computationally forbidding problem. Instead, at some cost of efficiency, we turn to the estimation of the two systems defined by (17′) and (19) and (17′) and (21)-(22).

2.3 Simulated Maximum Likelihood Estimation Method

The two systems of equations of interest here unfortunately cannot be consistently estimated using fixed-effect, analysis of covariance estimators. Because the rental variable is a qualitative, ordered probit analogue and because investment is censored, differencing equations between time periods (e.g., $k_{i2} - k_{i1}$) will no longer sweep away the time invariant latent component in either the rental or the investment equations (Hsiao, 1986). To get around this problem, we follow Gourieroux and Monfort (1993) and adapt simulated maximum likelihood methods to our problem. While we do not observe the vector of errors on the time invariant components for household i, $u_i = (u_i^f, u_i^\ell, u_i^k)'$, we can simulate using Monte Carlo methods. For each simulated replication, h, we can write a likelihood function conditional on u_{ih}. In the case of the land rental-investment system, there are 6 conditional likelihood regimes defined by the combinations of the 3 rental and the 2 investment censorship regimes. Appendix 2 below derives expressions for these 6 likelihood regimes. Letting $L_{ith}^R(\varepsilon_{it}^f, \varepsilon_{it}^k \mid u_{ih})$ denote the likelihood for observation k_{it} in regime R (R =1,6) conditional on replication u_{ih}, we can write the conditional likelihood for household i as:

$$L_{ih}(\Omega^k \mid u_{ih}) = \prod_{R=1}^{6} \Big(\prod_{t \mid k_{it} \ni R} L_{ith}^R(\varepsilon_{it}^f, \varepsilon_{it}^k \mid u_{ih}) \Big), \tag{23}$$

where Ω^k is the full vector of parameters defined by (17) and (21) above. Mean simulated log likelihood for household i is then given by:

$$(24) \qquad \overline{L_i}(\Omega^k) \equiv \ln[\frac{1}{H}\sum_{h=1}^{H} L_{ih}(\Omega^k \mid u_{ih})].$$

where H is the number of replications of the simulated error. Maximization of (24) summed across households will yield consistent estimators of the parameters in the model above, and will yield a good approximation of the true likelihood even with a moderate H, as long as different values of u_i are drawn for each observation (Gourieroux and Monfort, 1993). In the analysis that follows, H is set equal to 25.

In the case of the labor intensity decisions, there are only 3 regimes, as described in Appendix 2. The analogues to (23) and (24) for the labor-rental system of equations are straightforward.

Section 3 Econometric Results

To estimate the models developed in the prior section, we turn to panel data derived from two comprehensive surveys administered in eight provinces of China in 1988 and 1993.[17] The surveys contained both a household and a village questionnaire. Villages and households were chosen from the Rural Survey Base maintained by the Rural Survey Team of the State Statistical Bureau of China. The household questionnaire asked questions ranging from land rights, land transactions and annual agricultural production to off-farm employment. The village questionnaire asked questions about land tenure arrangements at the village level both in the surveyed years and in the history. In 1997, a supplementary village survey was

[17] The 1988 and 1993 surveys were designed by the Development Research Center under the State Council of China, with the assistance of the Land Tenure Center at University of Wisconsin-Madison, and implemented by the Rural Survey Team of the State Statistical Bureau. Both surveys covered the same 800 households in Jilin, Henan, Jiangxi, and Zhejiang provinces. Both surveys were financed by the Ford Foundation.

administered to fill institutional data that was missing from the prior surveys.

3.1 Variable Definitions and Descriptive Statistics

The current study draws on data from 3 of the 8 surveyed counties, Ning, Yueqin, and Shaoxin, in Zhejiang province and two counties, Nancheng and Anfu, in Jiangxi province. These counties were selected for analysis because rice is the staple crop in all of them. Complete data were available from both periods for 398 households in these rice producing counties.

Table 1 presents descriptive statistics for the key variables to be utilized in the econometric analysis. The average labor intensity of rice production rose by about 30% between the two survey periods. The intensity of investment (measured as the input of labor time into construction of wells, irrigation and drainage ditches, ponds, application of organic fertilizers, land flattening, soil improvement etc.) rose only slightly over the period, though as the standard deviations show it became much more variable over time.

The impact of property rights upon these two key allocation variables is of course the primary focus of this study. As described in Liu *et al.* (1998), distinct property rights regimes have evolved at the local level in the nearly two decades since the creation (or at least formal recognition) of the household responsibility system. To construct village and time specific measures of transfer rights and tenure security, the principle component method of factor analysis was used to create a one dimensional measure (a factor score) of both security and transfer rights from sets of multiple indicator variables.[18] The factor score variables are scaled as standard normal variables, with higher values indicating greater security and less

encumbered transfer rights, respectively.

For the land transfer variable, the available indicators concern the degree and extent of restrictions on use rights transfers and restriction on land rental. Since village collectives formally own land, there cannot be individual land sales in China. However, in some instances, farmers are entitled to sell their contractual use rights to the land allocated to them under the household responsibility system (HRS). As shown in Table 2, land transfer rights have on average become less restricted since 1998, with the average factor score rising to 0.4 from –0.4.

There are three indicators variables that signal the degree of tenure security enjoyed by a household: Whether their land holding will be reduced if a household's population is reduced; Whether their land holding will be increased if a household's population is increased; and, The frequency of land adjustments (average number of adjustments per year) since the establishment of HRS in the village. The factor score for tenure security has actually diminished over the 1999 to 1993 time period, reflecting in part the greater number of land reallocations that had taken place by 1993 as compared to 1988. In addition, in 1993 more villages reported that their rules stipulated reallocations based on household demographic changes.

Of the other variables needed for the analysis, one of the most problematic is the land rental rate, r_{jt}. Rental rate data were not recorded in the 1988 survey, and the analysis to follows thus relies on time and county dummy variables as well as a measure of village land scarcity (agricultural land per-capita) to control for differences in the rental rate. As can be seen in Table 2, land became slightly more scarce (relative to labor) over the period of the

[18] See Liu *et al.* (1998) for an in-depth presentation of the underlying property rights indicator variables.

panel. Other things equal, we would expect this land scarcity variable to be inversely related to the land rental rate.

Table 2 shows the other variables available for the analysis. The sample average off-farm employment ratio (measured at the village level) rose from 34% to 38% over the period.[19] Under the assumption that households adaptively form their expectations about future off-farm employment growth, this employment ratio variable measures ξ, the shifter of the employment shock distribution. Variables used to measure household agricultural productivity (and hence land and other factor demand in agriculture) are its endowment ratio[20] (contract land per-family member), household average years of formal schooling years, average age of household members, number of parcels of household operational land, and the percentage of contract land that is flat and therefore irrigable. Household average age is used to capture the household's experience in agriculture, though its effect could be mixed. For while it could increase agricultural productivity, it may also induce households to engage in more non-farm activities and thus accumulate specific human capital accordingly (Yao, 1997).[21] The number of parcels accounts for possible inefficiency associated with land fragmentation that is widely observed in China as a result of egalitarian distribution of land.

3.2 *Estimation Results*

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[19] In defining this variable, an industrial worker is defined as one who worked for more than one third of the year in local industry, and a labor is defined as a man within the age range of 16 to 60 and a woman 16 to 55.

[20] Because land and labor endowments are theoretically expected to work in opposite directions, we combine them into a single ratio in an effort to save degrees of freedom.

[21] In our reduced form context, one really can not predict the sign of any parameters. Here we only point out those forces that we think might be the strongest.

Table 1 above summarizes the key theoretical propositions to be tested. As shown in that table, both factor price equalization and investment regret effects are hypothesized to create linkages between endowments and factor use for autarchy households. Under the proposed econometric model, we cannot separately identify these two effects for autarchy households. However, as shown in table 1, endowment-dependent, non-separable factor use by households in the rent-in regime does uniquely identify an investment regret effect. Similarly, impacts of transfer rights on factor choice for autarchy households identifies a regret, but not a factor price equalization effect. Finally, the theoretical analysis suggests that any impact of transfer rights on factor choice by rent-out households uniquely identifies a factor price equalization effect.

As discussed in Section 2, the econometric strategy employed here utilizes a fixed effect analogue method to control for latent regional and household-specific components. Given that this approach places an already heavy load on the data, we restrict the effect of the other productivity control variables that influence land and factor productivity (see Table 2) to be identical across the land market participation regimes. Estimated values for these coefficients are presented in Appendix 3. Not surprisingly given the panel estimation method, these variables, most of which change relatively little over time, show little statistical significance. Exceptions are the wage variable, which is highly significant and has the expected negative sign in the labor intensity equation, and the variable measuring the number of parcels. This latter variable has a negative sign, indicating that when a household has a greater number of parcels, labor and investment decline. The nuisance parameters (the δ that

predict the latent effects) are not reported.[22] A number of them are significant, meaning that between-household variation in the observed variables contains significant explanatory power. However, because this variation is perfectly collinear with the effects of the latent, time-invariant factors, we eschew it completely from the analysis.

Table 3—the structure of which parallels that of Table 1—summarizes the primary findings concerning the effects of property rights. Somewhat surprisingly, the coefficient on the tenure security variable is small and statistically insignificant. In contrast, fairly strong statistical support emerges for the various transfer rights effects hypothesized above. First, greater transfer rights do significantly reduce the width of the autarchy regime via their impact on the thresholds or boundary points that determine when a household shifts regimes. Interestingly, for both the labor intensity and investment equations, this threshold effect is estimated to operate only on the boundary between autarchy and renting-out, whereas the effect on the rent-in to autarchy boundary is statistically insignificant. One explanation for this asymmetry is that a rent-out household bears more risks than a rent-in household when transfer rights are restricted. One such source of such differential risk is that renting out land could be regarded as a sign of politically unacceptable landlordist exploitation. Another source of such risk is that renting out land signals land abundance for its owner, and could expose the household to unfavorable land reallocation in the next period.

The separability or endowment dependence tests confirm the predictions of the theoretical model. For rent-out households, it is impossible to reject the hypothesis that factor choice is separable from the land-labor endowment ratio. For the other two regimes, there is a significantly negative effect of the endowment ratio on the intensity of both labor and

[22] The full results are available from the authors.

investment. For autarchy households, this non-separability results theoretically from both regret and factor price equalization effects. For rent-in households, non-separability uniquely identifies an investment regret effect. In addition to their relevance to the property rights issues of interest here, these non-separability results suggest that prior separability tests that have globally tested for separability by implicitly restricting all households to belong to the same regime may well have been mis-specified. An important exception to this pattern of global separability testing is the paper by Sadoulet, de Janvry and Benjamin (1998), which, like this one, finds that global separability restrictions are inappropriate.[23]

In addition to their threshold effects, less restricted transfer rights are also predicted to move factor choice in the rent-in and rent-out regimes closer together. Here, however, the econometric results do not conform to this theoretical expectation. Transfer rights have no significant effect on factor intensity in the rent-out regime, and the only significant coefficient (that linking investment intensity to transfer rights in the rent-in regime) has the opposite sign of that predicted by the model. These effects, which are a big part of the factor price equalization effect, thus appear to be quite weak.

In the absence of off-farm employment growth shocks, the theoretical analysis indicated that factor choice in the autarchy regime should be independent of transfer rights. In the presence of such shocks, that independence breaks down. As can be seen in Table 3, we estimate a weakly significant positive effect of less restricted transfer rights on investment and labor intensity. Like the finding of non-separable factor choice in the rent-in regime, this coefficient identifies the working of an investment regret effect.

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[23] Unlike the work here, the Sadoulet *et al.* (1998) paper derives distinct separability regimes based on labor market, not land market participation decisions under a theory of labor monitoring and other transactions costs.

Further evidence of significant investment regret effects appears in the coefficients relating factor choice to our regressive expectations-based measure of future off-farm employment growth. As predicted by the theory, we cannot reject the hypothesis that there are no pure regret effects for households in the rent-out regime. For the other two regimes, the relevant coefficients are significant and negative as predicted in three of the four cases. While these results are relatively strong, we did not find evidence of second order, regret mitigation effects. As can be seen in Table 3, the coefficients on the interaction between transfer rights and endowments and job shocks are insignificant for all three regimes, even though the theoretical model predicts significant regret mitigation (positive coefficients) for the rent-in and autarchy regimes.

In summary, the conservative estimation technique employed here has found substantial evidence concerning the impact of transfer rights upon investment and the efficiency of resource allocation. Among those households that do not participate in the land market, factor intensity and land productivity decline as contract land endowments increase, signaling monitoring or other transactions costs in the labor market. Less encumbered land transfer rights shrinks the portion of the endowment space in which autarchy is the optimal land market strategy, thereby moving the economy closer to full separability in which shadow factor prices are equalized across households. In addition, the econometric analysis uncovers consistent evidence of the investment dampening regret effects that would be expected in a rapidly industrializing economy where land rental transactions were inhibited by significant transactions costs. The ability of less encumbered transfer rights to mitigate those regret effects has not, however, been firmly established empirically.

Section 4 Conclusions and Policy Implications

While a number of studies have examined the economic effects of tenure security on agricultural investment and productivity, this paper has followed Besley (1995) and broadened the scope of investigation to include the transferability, as well as the security, of household residual income and use rights to land. The importance of transfer rights is likely to vary over time. When there is relatively little variation in factor endowment ratios across households (as in rural China following the household responsibility system reform of circa 1980), then trade restrictions should engender few costs. However, with industrialization, increasing complexity and household economic specialization, the potential for trade—and the economic costs of trade barriers—are likely to rise.

Contemporary China offers an interesting and important case to study the economic impacts of transfer rights alongside the more conventional tenure security effects. Industrialization has spread rapidly, if unevenly, across the country. Both over time and space rural China also exhibits notable variation in both tenure security and transfer rights, opening the way to the fuller investigation of the economics of property rights.

Using a theoretical model that presumes that agency costs block equalization of factor productivities through labor market transactions, this paper derived a number of specific hypotheses concerning the factor price equalization and investment regret mitigation effects of land transfer rights.[24] Panel data on a sample of farm households, analyzed with simulated maximum likelihood methods, revealed a number of interesting, occasionally surprising

[24] It should be stressed that because it presumes an egalitarian economy that is not marked by the sorts of unequal financial market access that create what Carter and Zimmerman call "countervailing market failures" the model here may be a poor guide to the impacts of transfer rights in inegalitarian economies.

results:

- •Consistent with the theory, separability between factor intensity and household endowments was rejected for rent-in and land market autarchic households and accepted for rent-out households. Such non-separability signals the usual allocative efficiency losses. The regime-specificity of the separability results also cautions against the global separability tests found in much of the peasant household literature.

- Via threshold effects, land transfer rights significantly reduce the domain of non-separable or endowment dependent factor allocation and thus enhance allocative efficiency via a factor price equalization effect.

- Consistent with the theory, rent-in and autarchic households exhibit a pure investment regret effect, with investment intensity declining as the proxy for expected future off-farm employment growth increases.

- While theory predicts that transfer rights should mitigate these regret effects, no such significant effects were found.

- Finally, a conventional tenure security variable fades into insignificance when its effects are simultaneously estimated with those of the transfer rights variables.

While this latter and most surprising result may simply be an artifact of a data set overburdened with variation-sacrificing panel methods and a complex regime switching structure, it does suggest that caution be applied to studies that look at security dimension of property rights in isolation from transfer rights. In an analysis of experimental tenure security reforms in a remote region of China, Kung (1999) suggests that the security-based investment effects have been overstated in this region. Left open by Kung's analysis, however, is the prospect that future industrialization and non-agricultural growth in this region may open it to the sort of investment regret and transfer effects explored here.

While it would be premature to issue policy proclamations based on the results presented here, they remain suggestive. For in addition to underwriting the notion that transfer rights may indeed emerge to be of dominant importance in an industrializing economy, they also suggest possible novel property rights configurations. In particular, if the investment

costs are modes for the sorts of periodic land redistributions that some authors have argued form a rural safety net, then a property rights system with incomplete tenure security but with strong transfer rights that permit specialization without regret may have much to recommend it.

Table 1
Summary of Theoretical Propositions*

	Land Rental Regimes		
	Rent-In	*Autarchy*	*Rent-Out*
Tenure Security Investment Demand Effect			
$\partial k/\partial S$		$\leftarrow > 0 \rightarrow$	
Factor Price Equalization			
Threshold Effects: $\partial \widetilde{T}_1^I / \partial M_1$		$\leftarrow > 0 \rightarrow$	
$\partial \widetilde{T}_1^O / \partial M_1$		$\leftarrow < 0 \rightarrow$	
Non-Separability/Endowment Dependence:			
$\partial \ell / \partial T^c , \partial k / \partial T^c$	$= 0$	< 0	$= 0$
Transfer Rights Dependence: $\partial \ell / \partial M_1 , \partial k / \partial M_1$	< 0	$= 0$	> 0
Investment Regret			
Pure Regret: $\partial k / \partial \xi , \partial \ell / \partial \xi$	< 0	< 0	$= 0$
Non-Separability: $\partial k / \partial T^c , \partial \ell / \partial T^c$	$\boldsymbol{< 0}$	< 0	$= 0$
Investment Regret Mitigation			
Transfer Rights Dependence: $\partial k / \partial M_1 , \partial \ell / \partial M_1$	< 0	$\boldsymbol{\neq 0}$	$= 0$
$\partial k / \partial T^c \partial M , \partial \ell / \partial T^c \partial M_1$	$\boldsymbol{> 0}$	$\boldsymbol{> 0}$	$= 0$
$\partial k / \partial a \partial M_1 , \partial \ell / \partial a \partial M_1$	$\boldsymbol{> 0}$	$\boldsymbol{> 0}$	$= 0$

* Note that the shadow price of labor, $\widetilde{\omega}$, moves in the opposite direction of labor intensity, while the expected second period shadow value of investment, $\widetilde{r}_2^k$, moves in the same direction as investment.

Table 2
Descriptive Statistics from Panel of Rice-Producing Households

	1988	*1993*
Factor Intensities		
Labor Intensity	233	312
(labor hours/*mu*)	[114]	[154]
Investment	6.9	8.0
(labor hours/*mu*)	[16.6]	[34]
Property Rights		
Transfer Rights Factor Score	-0.41	0.44
	[1.0]	[1.0]
Tenure Security Factor Score	0.25	-0.44
	[0.87]	[1.1]
Land Rental Rate		
Village Land Scarcity	3.0	2.7
(*mu* per-capita)	[1.8]	[1.8]
Household Endowment Ratio	2.3	2.4
(*mu*-per family member)	[1.7]	[2.1]
Off-Farm Employment Ratio	34%	38%
(village level)	[31]	[33]
Productivity Control Variables		
Village Off-Farm Wage Level	8.6	16.9
(Yuan/day)	[6.9]	[61]
Average Age	32	34
	[5.0]	[6.1]
Average Education	5.4	5.7
	[1.6]	[1.5]
% Flat Land	9.8%	7.6%
	[9.6]	[8.2]

* Figures in square brackets are estimated standard deviations.

Table 3
Econometric Results

	Land Rental Regimes		
	Rent-In	Autarchy	Rent-Out
Investment Intensity, k			
Tenure Security Effect, $\partial k/\partial S$		-0.01	
		(0.02)	
Transfer Rights Threshold Effects,		-0.06	
$\partial \tilde{T}_1^I/\partial M_1 > 0$;		(0.12)	
$\partial \tilde{T}_1^O/\partial M_1 < 0$;		-0.59**	
		(0.16)	
Non-Separability, $\partial k/\partial \tau^c$	**-0.06****	-0.03**	-0.02
	(0.01)	(0.01)	(0.04)
Transfer Rights Dependence: $\partial k/\partial M_1$	0.42**	**0.06***	0.14
	(0.18)	(0.04)	(0.72)
Pure Regret: $\partial k/\partial \xi$	-0.6	-0.90**	1.89
	(0.46)	(0.41)	(1.84)
Regret Mitigation	-0.01	-0.01	0.01
$\partial k/\partial \tau^c \partial M_1$	(0.01)	(0.01)	(0.03)
$\partial k/\partial \xi \partial M_1$	-0.27	0.001	-0.07
	(0.24)	(0.08)	(0.92)
Labor Intensity, ℓ			
Transfer Rights Threshold Effects,		-0.03	
$\partial \tilde{T}_1^I/\partial M_1$		(0.12)	
$\partial \tilde{T}_1^O/\partial M_1$		-0.55**	
		(0.15)	
Non-Separability, $\partial \ell/\partial \tau^c$	**-0.06****	-0.03**	-0.4
	(0.01)	(0.01)	(0.04)
Transfer Rights Dependence: $\partial \ell/\partial M_1$	0.03	**0.04**	0.32
	(0.15)	(0.03)	(0.51)
Pure Regret: $\partial k/\partial \xi$	-1.26**	-0.67*	1.89
	(0.41)	(0.36)	(1.14)
Regret Mitigation	-0.002	-0.006	-0.02
$\partial k/\partial \tau^c \partial M_1$	(0.01)	(0.006)	(0.03)
$\partial k/\partial \xi \partial M_1$	0.09	-0.02	-0.07
	(0.21)	(0.07)	(0.65)

Standard deviations computed from the inverse of the Hessian are reported in the parentheses.
*Significant at the 10% significance level.
** Significant at the 5% significance level.

Figure 1

The Factor Price Equalization Effect of Land Transfer Rights

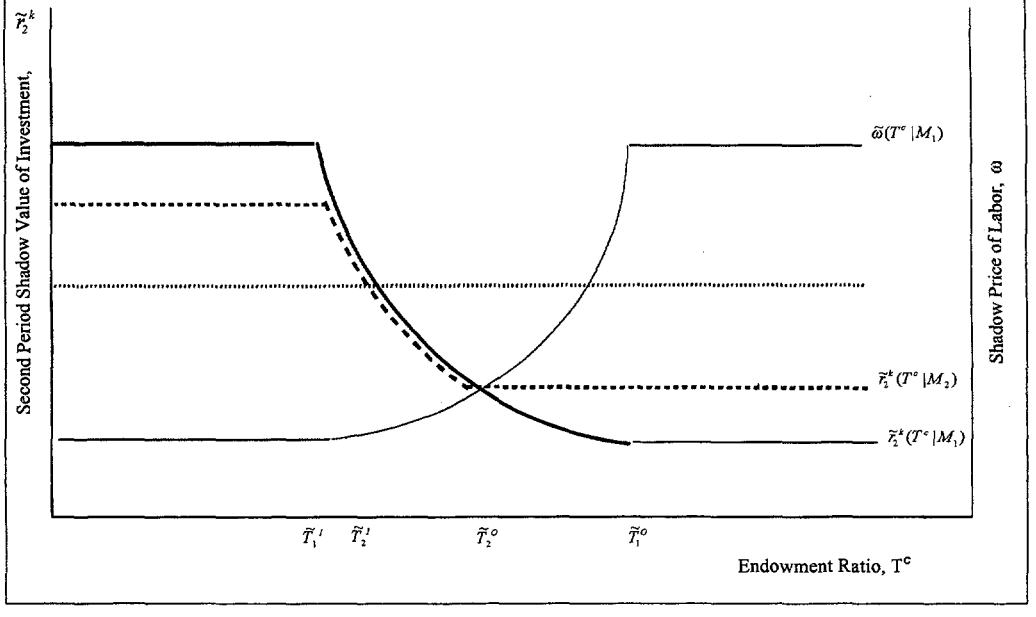
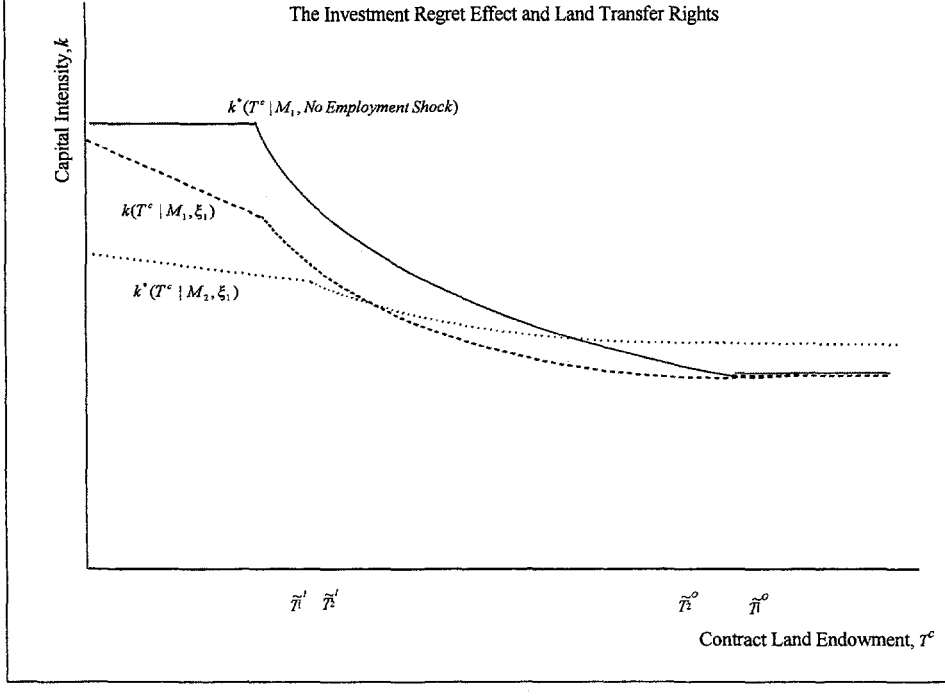


Figure 2

The Investment Regret Effect and Land Transfer Rights



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Appendix 1: Second Period Household Production Problem

This appendix derives results used in the text concerning the second period shadow value of first period investment in long-lived capital goods. In this appendix we ignore the case in which a land reallocation shock occurs as it is obvious that in that case the second period shadow value of first period investment is zero.

As described in the main body of the paper, we assume that all investment is undertaken in the first production period. In the second production period, households again make labor allocation decisions and decide how much area to cultivate. Households that invested in their rented land in the first period receive a rebate payment of v_k per-unit of installed capital on the land they rented in. Symmetrically, landlord households pay out rebates to first period renters who made investments in their contract land so that a household's net rebate payment is $v_k(k_1 R_1^I - k_1^O R_1^O)$, where k_1^O is the capital installed per-*mu* on land rented out by the other party in the first period. We assume that a household expects that v_k will equal its use value of the investment (note 14 in the text discusses this assumption in more detail). Land that is rented during the second period carries a surcharge based on the amount of capital installed. The full second period rental price for improved land is $(r_t + k_2^I v_k)$, where k_2^I is the amount of installed capital per-*mu* by the owner.

We assume that the employment shock θ is realized before the household makes its second period production decisions. The household's second period problem thus appears as:

$$
\begin{aligned}
&\underset{\substack{L_2^f, L_2^s \\ R_2^O, R_2^I}}{Max} && A_i F(L_2^f, K_2, T_2^f) + g(L_2^s) + w\bar{L}_2^E + v_k(k_1 R_1^I - k_1^O R_1^O) + \\
& && R_2^O(r_2^t - c^O(M_2) + v_k k_1^c) - R_2^I(r_2^t + c^I(M_2) + v_k k_2^I) \\
& && s.t. \\
& && K_2 = K_1 - R_1^I k_1 + R_1^O k_1^O + R_2^I k_2^I - R_2^O k_1^c \\
&\text{(A1.1)} && k_1^c = k(k_1, k_1^O) \\
& && T_2^f = T^c + R_2^I - R_2^O \\
& && L_2^f + L_2^s \le \bar{L} - \bar{L}_2^E \\
& && \bar{L}_2^E = \bar{L}_1^E + \theta \\
& && L_2^f, L_2^s, R_2^I, R_2^O \ge 0
\end{aligned}
$$

where k_1^c is the capital intensity on that portion of the household's contract land endowment that it rents out in the second period. Note that k_1^c would in general depend on how intensively the household invested in the land it cultivate (k); how intensively its tenants invested in the first period (k_1^O); and, on exactly which land the household chose to rent-out in the second period. To reduce complexity that adds no insight, we assume in the analysis that follows that each household *ex ante* expects others in the village to have the same first period investment intensity that it does so that k_1, k_1^O, k_2^I and k_1^c are all the same. Under these

assumptions and specification of the problem that guides optimal second period behavior, we can derive the expected marginal product of the first period investment K_1, $\tilde{r}_2^k$

A1.1. *Factor Price Equalization Effects without Employment Shocks*

In order to isolate factor price equalization from regret effects, we first consider the case of no employment shocks. Denote the value function of the problem in (A1.1) by $\pi_2^*(..)$. Recall that we define the expected second period value of investment as $\tilde{r}_2^k = \frac{\partial E\pi_2^*}{\partial K_1}$. Using the envelope theorem, this reduces to:

$$\text{(A1.2)} \quad \begin{aligned} \tilde{r}_2^k &= AF_K(\ell_2^*, k_2^*)(1 - \frac{R_1^I}{T_1} - \frac{R_2^O}{T_1}\frac{\partial k_1^c}{\partial k_1}) + \frac{R_1^I}{T_1} Ev_k + \frac{R_2^O}{T_1}\frac{\partial k_1^c}{\partial k_1} Ev_k \\ &= AF_K(\ell_2^*, k_2^*) \end{aligned}$$

where for notational simplicity we have omitted the discount factor β. The last equality is obtained by using the simplifying assumption that Ev_K is equal to the marginal product of investment under own use.

To understand the factor equalization effect in the first period, note that k_2^* is constant in the second period as there is no added investment and a change in land holding does not change the investment intensity. Therefore, the only way that $\tilde{r}_2^k$ can change is through changes in labor intensity. For reasons identical to those discussed in the text for first period resource allocation, labor intensity in the second period does not depend on land endowment for a household in either rent-in or rent-out regime, and decreases in land endowment for one in autarky regime. Therefore, under the assumption that $F_{LK} > 0$:

$$\frac{\partial \tilde{r}_2^k}{\partial T^c} \begin{cases} = 0, & \text{for rent - in or rent - out regime} \\ < 0, & \text{for autarky} \end{cases}$$

Again for reasons identical to those discussed in the text for the first period problem, note that labor intensity decreases, is constant, or increases in transfer rights M_1 when a household is in rent-in, autarky, or rent-out regime:

$$\frac{\partial \tilde{r}_2^k}{\partial M_1} \begin{cases} < 0, & \text{for rent - in regime} \\ = 0, & \text{for autarky} \\ > 0, & \text{for rent - out regime} \end{cases}$$

A1.2. *Regret Effects in the Presence of Employment Growth Shocks*

The impacts of off-farm employment growth shocks on the expected second period

value of investment $\tilde{r}_2^k$ are most easily seen by separately analyzing the first period land market participation regimes.

A1.2.1. *Regret Effects for Households that Rent-In Land in the First Period*

For this case, a household expects to stay in the rent-in regime or move to the autarky regime depending on the size the employment shock it receives. As developed in the text, denote the critical shock value such that this switch place as $\tilde{\theta}^I$, and recall that

$$\text{(A1.3)}\quad \frac{\partial \tilde{\theta}^I}{\partial T_c} < 0, \quad \frac{\partial \tilde{\theta}^I}{\partial M_2} > 0.$$

The expected shadow price of first period investment for this case is:

$$\text{(A1.4)}\quad \tilde{r}_2^k = \int_0^{\tilde{\theta}^I} F_K^I(\ell^{I*}, k_2)\phi(\theta;\xi)d\theta + \int_{\tilde{\theta}^I}^{\bar{\theta}} F_K^A(\ell_2^A(\theta, T^c), k_2)\phi(\theta;\xi)d\theta$$

where the superscript I denotes rent-in regime, and ℓ^{I*} is the optimal labor intensity for that regime and is determined by the following equation

$$\text{(A.1.5)}\quad F_T^A(\ell^{I*}, k_2) = r_2^I + c^I(M_2) + v_k k_2^I.$$

Comparing (A1.4) with (11) in the text, we have $\ell^{I*} = \ell_2^A(\tilde{\theta}^I, T^c)$, so that

$$F_K^I(\ell^*, k_2) = F_K^A(\ell_2^A(\tilde{\theta}^I, T^c), k_2).$$

Using this result and integrating the second integral in (A1.4) by parts, we get

$$\text{(A1.6)}\quad \tilde{r}_2^k = F_K^A(\bar{\theta}, T^c) - \int_{\tilde{\theta}^I}^{\bar{\theta}} \Phi(\theta;\xi)dF_K^A(\theta, T^c)$$

Under the stochastic assumptions made in the text, note that $\partial\Phi(\theta;\xi)/\partial\xi < 0$, and $dF_K^A(\theta, T^c) = (\partial F_K^A(\theta, T^c)/\partial\theta)d\theta < 0$. Using (12) in the text, the following results follow:

$$\frac{\partial \tilde{r}_2^k}{\partial \xi} = -\int_{\tilde{\theta}^I}^{\bar{\theta}} \frac{\partial \Phi(\theta;\xi)}{\partial \xi} dF_K^A(\theta, T^c) < 0$$

$$\frac{\partial \tilde{r}_2^k}{\partial T^c} = \int_{\tilde{\theta}^I}^{\bar{\theta}} \frac{F_K^A(\theta, T^c)}{\partial T_c}\phi(\theta;\xi)d\theta < 0$$

$$\frac{\partial \tilde{r}_2^k}{\partial M_1} = \frac{\partial \tilde{\theta}^I}{\partial M_2}\Phi(\tilde{\theta}^I;\xi)dF_K^A(\tilde{\theta}^I, T^c) < 0$$

$$\frac{\partial^2 \tilde{r}_2^k}{\partial \xi \partial M_1} = \frac{\partial \tilde{\theta}^I}{\partial M_2} \frac{\partial \Phi(\tilde{\theta}^I;\xi)}{\partial \xi} dF_K^A(\tilde{\theta}^I, T^c) > 0$$

$$\frac{\partial \tilde{r}_2^k}{\partial T^c \partial M_1} = -\frac{\partial \tilde{\theta}^I}{\partial M_2} \frac{F_K^A(\tilde{\theta}^I, T^c)}{\partial T^c} \phi(\tilde{\theta}^I;\xi) > 0$$

A1.2.2. *Regret Effects for Households in First Period Autarky*

As described in the text, that analysis for a household in first period autarky parallels the case just analyzed for households that rent-in land. There is again a critical employment shock, $\tilde{\theta}^O$, such that the household switches land market regime. The value of this shock is determined by:

(A1.7) $F_T^A(\ell_2^A(\tilde{\theta}^O, T^c), k_2) = r_2^t - c^O(M_2) + v_k k_1^c$

where the implicit function theorem shows:

(A1.8) $\frac{\partial \tilde{\theta}^O}{\partial T^c} < 0, \quad \frac{\partial \tilde{\theta}^O}{\partial M_2} < 0$

Integrating by parts and using the same assumptions as in the rent-in case, (15) in the text can be rewritten as:

(A1.9) $\tilde{r}_2^k = F_K^O(\ell^{O*}, k_2) - \int_0^{\tilde{\theta}^O} \Phi(\theta;\xi) dF_K^A(\theta; T^c)$,

yielding the following comparative static results:

$$\frac{\partial \tilde{r}_2^k}{\partial \xi} = -\int_0^{\tilde{\theta}^O} \frac{\partial \Phi(\theta;\xi)}{\partial \xi} dF_K^A(\theta, T^c) < 0$$

$$\frac{\partial \tilde{r}_2^k}{\partial T^c} = \int_0^{\tilde{\theta}^O} \frac{F_K^A(\theta, T^c)}{\partial T^c} \phi(\theta;\xi) d\theta < 0$$

$$\frac{\partial \tilde{r}_2^k}{\partial M_1} = \frac{\partial F_K^O(\ell^{O*}, k_2)}{\partial M_2} - \frac{\partial \tilde{\theta}^O}{\partial M_2} \Phi(\tilde{\theta}^O;\xi) dF_K^A(\tilde{\theta}^O, T^c) \lesseqgtr 0$$

$$\frac{\partial^2 \tilde{r}_2^k}{\partial \xi \partial M_1} = -\frac{\partial \tilde{\theta}^O}{\partial M_2} \frac{\partial \Phi(\tilde{\theta}^O;\xi)}{\partial \xi} dF_K^A(\tilde{\theta}^O, T^c) > 0$$

$$\frac{\partial \tilde{r}_2^k}{\partial T^c \partial M_1} = \frac{\partial \tilde{\theta}^O}{\partial M_2} \frac{F_K^A(\tilde{\theta}^O, T^c)}{\partial T^c} \phi(\tilde{\theta}^O;\xi) > 0$$

Note that sign of $\frac{\partial \tilde{r}_2^k}{\partial M_1}$ is indeterminate. Intuitively, this indeterminacy results from the fact that while greater transfer rights increase the probability that a household will fall into the rent-out regime and thus have to settle for the relatively low returns to capital it will receive when it rents-out land. At the same time, however, returns improved transfer rights raise the returns the household will receive in this case. While these effects are offsetting, we can say that the positive effects will eventually dominate as either the stochastic structure shifts or as contract land endowment increases. To see this, note that the second term in the expression for $\frac{\partial \tilde{r}_2^k}{\partial M_1}$ decreases in ξ, and for a given endowment. There will therefore exist a critical value of ξ, $\bar{\xi}$, say, such that

$$\frac{\partial \tilde{r}_2^k}{\partial M_1}\begin{cases} <0, \text{ if } \xi < \bar{\xi}; \\ =0, \text{ if } \xi = \bar{\xi}; \\ >0, \text{ if } \xi > \bar{\xi}. \end{cases}$$

Similarly, for a given stochastic structure, there exists a critical endowment level such that $\frac{\partial \tilde{r}_2^k}{\partial M_1}$ becomes positive for endowments greater than that critical level. As shown in Figure 2, the impact of improved transfer rights is thus to rotate the relationship between shadow price and contract land endowment.

A1.2.3. *Regret Effects for Households that Rent-Out Land in the First Period*

As discussed in the text, there are no regret effects for households in this regime.

Appendix 2: Conditional Likelihood Functions

There are six conditional likelihood regimes for the estimation of the investment intensity, and three for labor intensity. This appendix derives the likelihood function for the investment regimes. The regimes for the labor intensity equation are essentially the same as in cases (2), (4), and (6) below. Each of the likelihood functions shown here is conditional on a particular Monte Carolo replication of $u_h = (u_h^f, u_h^k)'$. However, to cut down on clutter, the notation indicating this conditioning has been captured simply as a subscript *h* on those terms that depend on the simulated errors.

Regime 1: Rent-in, k = 0

$$
\begin{aligned}
L_{ith}^1 &= \Pr(\varepsilon_{it}^{\ R} > b_{it}, k_{it}^{\ *} \le 0) \\
&= \int_{-\infty}^{k_{it}-A_{ith}} \int_{b_{ith}}^{\infty} \varphi(\varepsilon_{it}^{\ R}, \varepsilon_{it}^{\ K}) d\varepsilon_{it}^{\ R} d\varepsilon_{it}^{\ K} \qquad \text{(A2.1)} \\
&= \Phi[(k_{it} - A_{ith}^I)/\sigma_K, -b_{ith}, -\rho_{RK}],
\end{aligned}
$$

where $\varphi(\bullet)$ stands for the joint distribution of $\varepsilon_{it}^{\ R}$ and $\varepsilon_{it}^{\ K}$, Φ stands for the *cdf* of the standard bivariate normal distribution, and $A_{ith}^I = X_{it}^k \beta^I + v_{ih}^{\ k}$. The ε_{it} terms for this and the other regimes are as defined in (+2') and (+6) of the text.

Regime 2: Rent-in, k > 0

$$
\begin{aligned}
L_{ith}^2 &= \int_{b_{it}}^{\infty} \varphi(\varepsilon_{it}^{\ R}, \varepsilon_{it}^{\ K}) d\varepsilon_{it}^{\ R} \\
&= \frac{1}{\sigma_K} \phi(\varepsilon_{it}^{\ K}/\sigma_K) \int_{b_{ith}}^{\infty} \varphi_c(\varepsilon_{it}^{\ R} \mid \varepsilon_{it}^{\ K}) d\varepsilon_{it}^{\ R} \qquad \text{(A2.2)} \\
&= \frac{1}{\sigma_K} \phi\left(\frac{k_{it} - A_{ith}^I}{\sigma_K}\right)\left[1 - \Phi\left(\frac{b_{ith} - m_c}{\sigma_c}\right)\right],
\end{aligned}
$$

where ϕ stands for the *pdf* of the standard normal, and $m_c = \beta_c \varepsilon_{it}^{\ K}$ and $\sigma_c = \text{sqrt}(\sigma_R^2 - \beta^2 \sigma_K^2)$, with $\beta_c = \rho_{RK}\sigma_R/\sigma_K$ are the mean and standard deviation of the conditional distribution φ_c, respectively.

Regime 3: Rent-out, k = 0

$$L_{ith}^{3} = \Pr(\varepsilon_{it}^{R} < a_{it}, k_{it}^{*} \le 0)$$

$$= \int_{-\infty}^{k_{it}-A_{ith}} \int_{-\infty}^{a_{ith}} \varphi(\varepsilon_{it}^{R}, \varepsilon_{it}^{K}) d\varepsilon_{it}^{R} d\varepsilon_{it}^{K} \quad \text{(A2.3)}$$

$$= \Phi[(k_{it} - A_{ith}^{O})/\sigma_{K}, a_{ith}, \rho_{RK}].$$

where $A_{ith}^{O} = X_{it}^{k}\beta^{O} + v_{ih}^{k}$.

Regime 4: Rent-out, k > 0

$$L_{ith}^{4} = \int_{-\infty}^{a_{ith}} \varphi(\varepsilon_{it}^{R}, \varepsilon_{it}^{K}) d\varepsilon_{it}^{R}$$

$$= \frac{1}{\sigma_{K}} \phi(\varepsilon_{it}^{K}/\sigma_{K}) \int_{-\infty}^{a_{ith}} \varphi(\varepsilon_{it}^{R} \mid \varepsilon_{it}^{K}) d\varepsilon_{it}^{R} \quad \text{(A2.4)}$$

$$= \frac{1}{\sigma_{K}} \phi\left(\frac{k_{it} - A_{ith}^{O}}{\sigma_{K}}\right) \Phi\left(\frac{a_{ith} - m_{c}}{\sigma_{c}}\right).$$

Regime 5: Autarky, k = 0

$$L_{ith}^{5} = \Pr(a_{it} \le \varepsilon_{it}^{R} \le b_{it}, k_{it}^{*} \le 0)$$

$$= \int_{-\infty}^{k_{it}-A_{ith}} \int_{a_{ith}}^{b_{ith}} \varphi(\varepsilon_{it}^{R}, \varepsilon_{it}^{K}) d\varepsilon_{it}^{R} d\varepsilon_{it}^{K} \quad \text{(A2.5)}$$

$$= \Phi[(k_{it} - A_{ith}^{A})/\sigma_{K}, b_{ith}, \rho] - \Phi[(k_{it} - A_{ith}^{A})/\sigma_{K}, a_{ith}, \rho_{RK}].$$

where $A_{ith}^{A} = X_{it}^{k}\beta^{A} + v_{ih}^{k}$.

Regime 6: Autarky, k > 0

$$L_{ith}^{6} = \int_{a_{ith}}^{b_{ith}} \varphi(\varepsilon_{it}^{R}, \varepsilon_{it}^{K}) d\varepsilon_{it}^{R}$$

$$= \frac{1}{\sigma_{K}} \phi(\varepsilon_{it}^{K}/\sigma_{K}) \int_{a_{it}}^{b_{it}} \varphi(\varepsilon_{it}^{R}, \varepsilon_{it}^{K}) d\varepsilon_{it}^{R} \quad \text{(A2.6)}$$

$$= \frac{1}{\sigma_{K}} \phi\left(\frac{k_{it} - A_{ith}^{A}}{\sigma_{K}}\right) \left[\Phi\left(\frac{b_{ith} - m_{c}}{\sigma_{c}}\right) - \Phi\left(\frac{a_{ith} - m_{c}}{\sigma_{c}}\right)\right].$$

Appendix 3. Results of the Econometric Estimation[1]

Parameters	Investment Intensity		Labor Intensity	
	Rental Decision	Investment Equation	Rental Decision	Labor Equation
Village land endowment	-0.080		-0.086	
	(0.352)		(0.350)	
Variables for transaction costs				
Constant for rent-in	-0.426		-0.445	
	(0.894)		(0.880)	
Transfer rights for rent-in	-0.063		-0.028	
(threshold effect for rent-in)	(0.118)		(0.118)	
constant for rent-out	5.086**		4.989**	
	(0.917)		(0.902)	
Transfer rights for rent-out	-0.586**		-0.550**	
(threshold effect for rent-out)	(0.158)		(0.154)	
Shared Variables				
Year dummy (1993 = 1)	-0.904**	0.064	-0.886**	0.129
	(0.258)	(0.050)	(0.249)	(0.043)
Household land endowment	0.021		0.019	
	(0.047)		(0.047)	
Average education	0.093	0.016	0.080	-0.001
	(0.129)	(0.029)	(0.128)	(0.025)
Average age	0.002	0.001	0.008	0.001
	(0.024)	(0.005)	(0.024)	(0.004)
Parcels of land	0.060**	-0.007**	0.606**	-0.012**
	(0.020)	(0.003)	(0.203)	(0.003)
Ratio of flat land	0.028	0.006	0.061	-0.014
	(0.191)	(0.044)	(0.198)	(0.041)
Village industrial wage	-0.228	0.045	-0.182	-0.152**
	(0.195)	(0.052)	(0.191)	(0.044)
Ratio of village industrial labor	-3.110**		-3.127**	-0.016
	(1.468)		(1.446)	(0.021)
Tenure security	-0.105	-0.013	-0.144	
	(0.112)	(0.024)	(0.111)	
Rent-in Regime				
Constant		5.179**		5.998**
		(0.330)		(0.272)
Transfer rights		0.416**		0.032
		(0.176)		(0.154)
Household land endowment		-0.061**		-0.058**
		(0.014)		(0.012)
Ratio of village industrial labor		-0.601		-1.263**
		(0.466)		(0.405)
Transfer rights × household land endowment		-0.012		-0.002
		(0.015)		(0.013)

Transfer rights × ratio of village industrial labor	-0.273	0.098
	(0.243)	(0.217)
Village land endowment	0.162	-0.197**
	(0.103)	(0.086)
Autarchy Regime		
Constant	5.798**	5.620**
	(0.253)	(0.244)
Transfer rights	0.064*	0.044
	(0.037)	(0.034)
Household land endowment	-0.032**	-0.032**
	(0.012)	(0.010)
Ratio of village industrial labor	-0.901**	-0.672**
	(0.408)	(0.357)
Transfer rights × household land endowment	-0.007	-0.006
	(0.007)	(0.006)
Transfer rights × ratio of village industrial labor	0.001	-0.020
	(0.084)	(0.075)
Village land endowment	-0.044	-0.168**
	(0.072)	(0.063)
Rent-out Regime		
Constant	2.845	2.981**
	(1.794)	(1.178)
Transfer rights	0.150	0.323
	(0.723)	(0.515)
Household land endowment	-0.023	-0.047
	(0.047)	(0.038)
Ratio of village industrial labor	1.892	1.898
	(1.843)	(1.140)
Transfer rights × household land endowment	0.006	-0.023
	(0.033)	(0.028)
Transfer rights × ratio of village industrial labor	-0.068	-0.073
	(0.921)	(0.655)
Village land endowment	0.466	0.194
	(0.374)	(0.266)

1. The number of cases is 794, with equal number of cases for each of the two periods. Standard deviations computed from the inverse of the Hessian are reported in the parentheses.
* Significant at the 10% significance level. ** Significant at the 5% significance level.

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